SMART CITY INSTITUTE
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PERFORMANCE MEASUREMENT IN SMART CITIES

AN INTRODUCTORY REPORT

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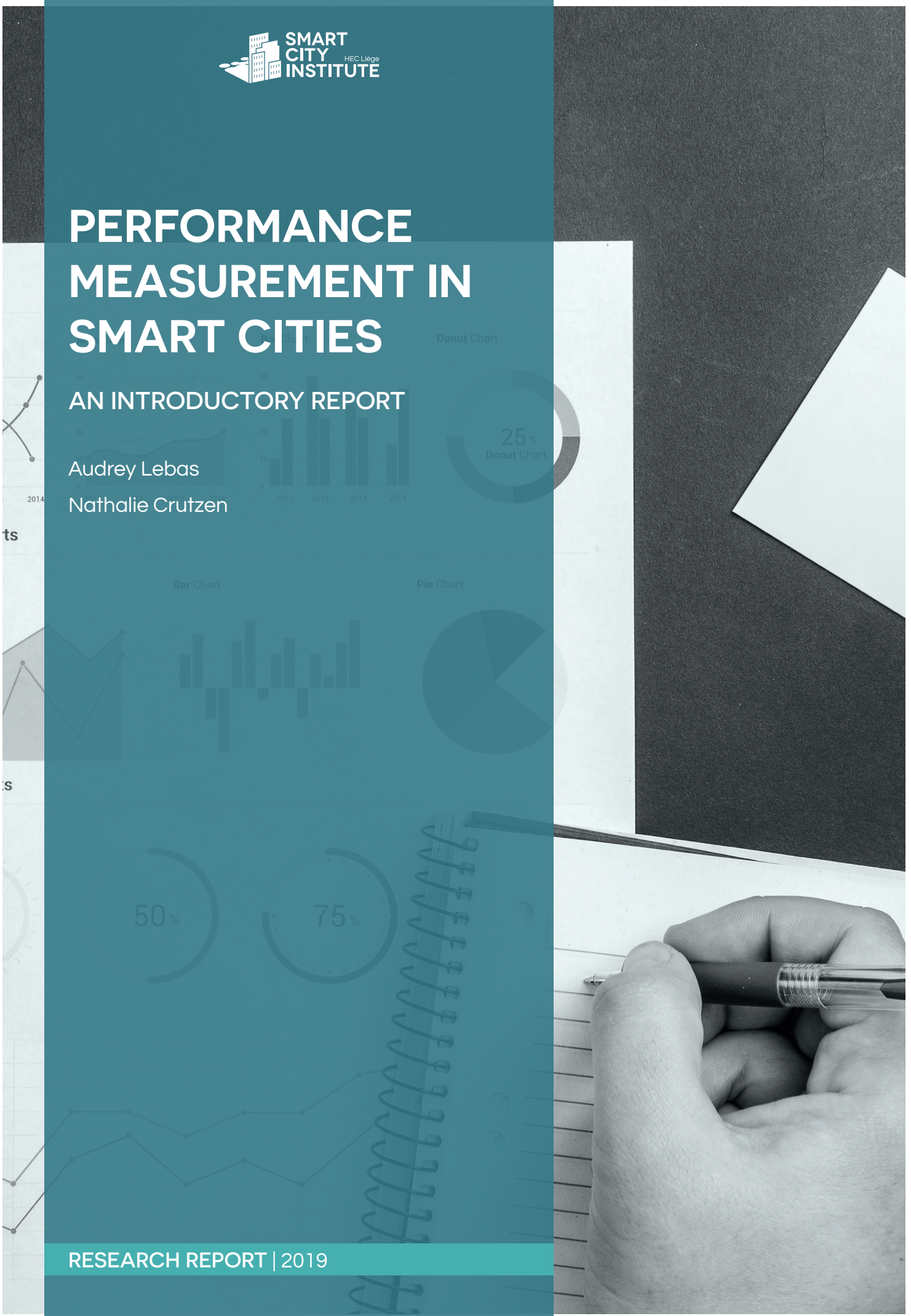
Nathalie Crutzen



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PERFORMANCE MEASUREMENT IN SMART CITIES

AN INTRODUCTORY REPORT

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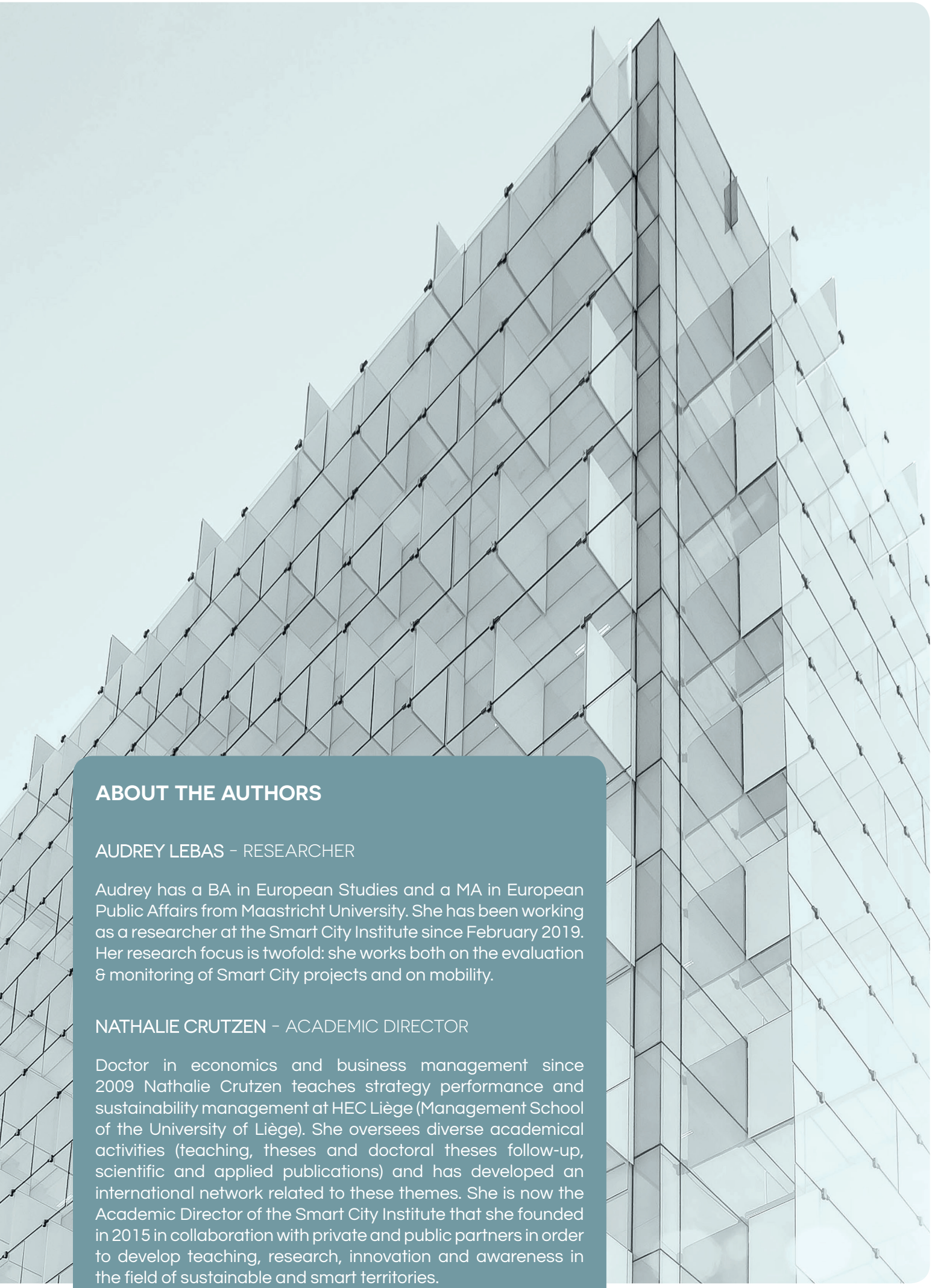

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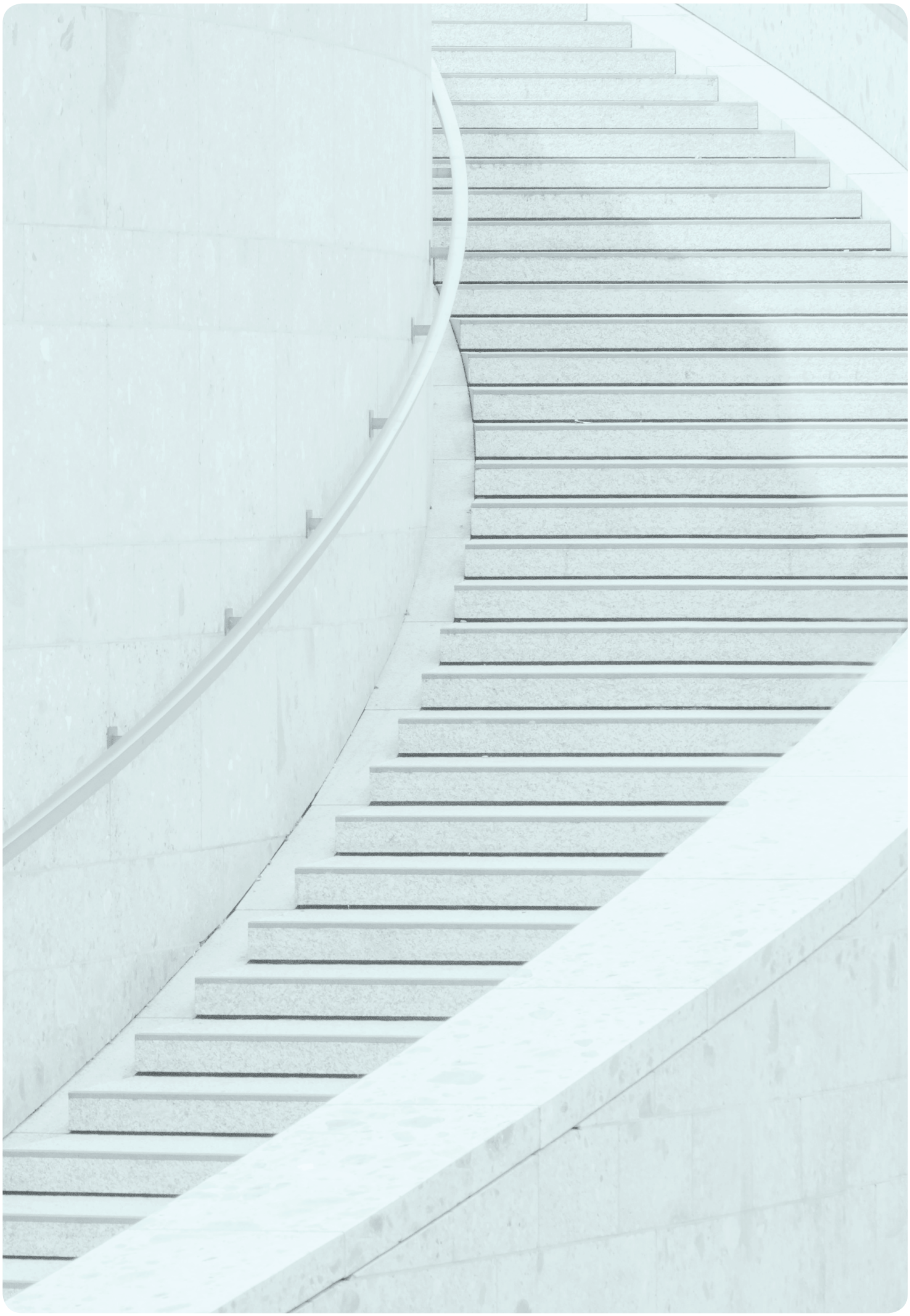

EXECUTIVE SUMMARY

Among the different debates surrounding Smart Cities, the topic of performance measurement has gained momentum. Several authors (e.g. Giffinger, 2007) and projects (e.g. CityKeys[1]) have provided frameworks for municipalities to measure and monitor their Smart City performance. While these frameworks are useful and interesting, they often measure the performance of a city with an outside-in approach. This implies that performance is often measured based on pre-defined sets of indicators, which is an asset for comparing territories. In this report, we focus on a more managerial approach – also called an inside-out approach. We aim to guide municipalities to define their own performance measurement system that will allow them to improve their objectives and processes. Hence, we hereby propose an integrative model that is directly derived from the territory's specificities. The model is constructed using an inductive approach built upon the existing literature on business performance management, public performance management and Smart City performance measurement & management. Note that, given the complexity of performance measurement, this report is only an introductory document. Therefore, the content is not exhaustive and will be completed in future publications from the Smart City Institute.

[1]Funded by the European Union HORIZON 2020 programme, with the aid of cities, CITYkeys has developed and validated key performance indicators and data collection procedures for common and transparent monitoring, as well as improving the comparability of Smart City solutions across European cities (CITYKeys, n.d.)

INTRODUCTION

In recent years, the concept of Smart City has become very popular. Debates regarding its definition and its *raison d'être* have flourished. For some, "*unleashing the 'smart' potentials of a city has been recognised as a strategy to maintain the city's relevance in an increasingly connected world*" (Adnan, 2016, p. 2). For others, "*the boom for Smart Cities is mainly related to the prime role of cities in the social and economic aspects of people and in their huge impact on environmental sustainability*" (Mori & Christodoulou, 2012). In any case, Smart City strategies and Smart City projects have bloomed around the globe, ranging along a wide spectrum from very emblematic technological greenfield Smart Cities to very small local projects focusing on e-governance (Caird, 2017).

While there is still no commonly agreed definition of Smart Cities, there tends to be a consensus on the fact that, to be considered "smart", cities or municipalities should be embracing some of the following 6 dimensions: smart economy, smart people, smart governance, smart mobility, smart environment and smart living (Giffinger, 2007; Lombardi & al., 2012). However, it is important to have a more complete definition that will ground the reflections of this report. Therefore, a Smart City will be defined here as:

- a stakeholder ecosystem (governments, citizens, companies, associations, NGOs, universities, international institutions) ;
- on a given territory ;
- engaged in **a sustainable transition process** (i.e., ensuring growth and economic prosperity, social welfare and the respect of natural resources on that given territory) ;
- while using (digital) technologies as a means ;
- to reach sustainable objectives and successfully complete actions related to these objectives (Smart City Institute, 2017).

In addition, **the well-being and quality of life of the citizens** is also frequently emphasised as the ultimate objective of any Smart City (Carli & al., 2013; Merli, 2014; Dameri, 2017a). While the term "well-being" is still highly debated, scholars generally agree that well-being includes: the presence of positive emotions and moods, the absence of negative emotions, satisfaction with life, fulfilment and positive functioning (Andrews & Withey, 1976; Diener, 2000; Veenhoven, 2008). Put simply, well-being can be interpreted as judging life positively and feeling good.

Among various debates, the topic of performance measurement at a city scale has gained interest. Performance measurement and monitoring are becoming increasingly essential tools that enable cities to clarify their mission and translate it into action (Carli & al., 2013). **By developing performance measurement models, cities are able to explain how smart initiatives produce value** and how much they are able to generate public value for citizens (Dameri, 2015). In this respect, a number of authors (e.g. Giffinger, 2007; Zygiaris, 2013; Carli & al., 2013; Adnan, 2016; Dameri, 2017b) and projects (e.g. Citykeys) have developed frameworks to assess the performance of Smart Cities.

While the quality of these projects and research is unequivocal, most of them tend to measure the performance of cities with an outside-in approach. This suggests that they generally measure performance based on predefined sets of indicators that allow comparisons to be made between territories (Kaas & al., 2016). In this report, we choose to approach performance measurement from a different angle and focus on the inside-out approach. This implies that, as every city is different, the performance measurement system is based on each territory's specificities. Hence, we aim to provide guidance for municipalities to develop their own Smart City performance measurement system.

Consequently, this report asks the following question: **how can municipalities develop their own Smart City performance measurement framework?**

Based on previous literature, we propose an integrative method. More concretely, this step by step method is constructed using an inductive approach based on the literature related to business performance management, public performance management and existing Smart City performance measurement and management. Completing the discussion using elements that issue from sustainable business performance management and public performance management literature lends a true added value as transferring theories from these fields allows us to fill gaps in the Smart City research field.

This report proceeds as follows. The first part is dedicated to an explanation of what performance mea-

surement is and why it matters in the context of Smart Cities. This includes a clarification of the links between the terms performance measurement and performance management. After detailing why we focus on the "inside-out" management approach in the second section, the third part consists in the presentation of our integrated method for Smart City performance measurement. We start by quickly covering the necessity of analysing the specificities and structure of the municipality, and the definition of the Smart City's objectives and strategy. In the last section, and the core of this report, we go into detail on the establishment of indicators, data collection methods, targets and data valorisation.

01

SMART CITY PERFORMANCE MEASUREMENT

Studies on performance measurement first appeared in the context of business management (Bouckaert & Peters, 2002). According to Lebas (1995), performance is "*about deploying and managing well the components of the causal model(s) that lead to the timely attainment of stated objectives within constraints specific to the firm and to the situation.*" (p. 29). **Measuring performance is thus key to understanding where an organisation has been, where it stands now, what its objectives in the future are and how to reach those, as well as to flag when those objectives have been reached** (Lebas, 1995). There is a close relationship between performance measurement and performance management. They are part of the same loop: performance management precedes and follows performance measurement, in a virtuous spiral, and performance management creates the context for measurement (ibid.). Performance measurement can be defined as "*the process of collecting, analysing and communicating (…) performance information in order to support better management decisions*" (Kaas & al., 2016). In other words, performance measurement is part of the performance management process but the opposite is not true. **Performance measurement is the translation of objectives into concrete and measurable results. Performance management is what you decide to put in place as a result of the measurement (e.g. hiring more people, training, reducing budgets)** (Lebas, 1995). While both concepts are important, the scope of this report principally focuses on performance measurement.

In order to measure performance, one must establish indicators. Indicators are by definition quantitative, qualitative or descriptive measures that enable information on a complex phenomenon to be simplified into a form that is relatively easy to use and understand (Anthopoulos & al., 2016; Huovala & al., 2019). Thus, **performance indicators are variables collected from the past that tell us how close we have come to reaching our objectives** (Lebas, 1995; Bouckaert & Van Dooren, 2009). Administrative functions of performance indicators include the establishment of goals and results (performance tracking), estimation and justification of resource requirements and reallocation (organisational learning), development of organisation-improvement strategies (strategic decision making), motivation for employees to improve performance, and control of operations (Holzer & Yang, 2004).

Over the years, performance measurement has moved from being purely a business concept to the public sector (Van Thiel & Leeuw, 2002). In the 1980s, due to economic decline and increasing international reforms, market type mechanisms were introduced to the public sector to improve the efficiency and effectiveness of policy making (ibid.). This paradigm shift was heavily influenced by the conviction that private organisations are more efficient than public ones (Schiavo-Campo, 1999; Van Thiel & Leeuw, 2002).

Over time the idea of 'evidence-based policy' has further boosted the establishment of performance indicators to inform policy delivery and development (Holzer & al., 2017). Performance indicators have become major factors in governmental procedures, strongly bound to pragmatic planning of budgets. Indicators do not drive policy but are important components as they help to shape perceptions about which policies will be estimated as viable and relevant (Hezri & Dovers, 2006; Lehtonen, 2015).

In addition to being a policy tool for officials in order to determine adequate resources and prioritise issues, establishing indicators is a valuable asset for different reasons (Lehtonen, 2015; Holzer & al., 2017):

- Indicators enable politicians to measure and evaluate the performance of public and private policy-implementing organisations and thus can hold public managers to account
- Indicators foster and simplify the understanding of

key issues and trends, both internally (i.e., within the administration, with other departments and levels of hierarchy) and externally (i.e., stakeholders such as the public and media);

- Indicators can promote greater transparency by acting as a means of communication with citizens to raise awareness of the objectives and achievements (Lehtonen, 2015).

Indicators are generally expected to enhance the rationality of policy-making and public debate by providing a more objective, robust, and reliable information base (Lehtonen, 2015, p. 76). This is also applicable to the domain of Smart Cities. Similar to the arguments put forward in the previous section, indicators help leaders, managers and policy makers to make intelligent decisions about where to focus time and resources while ensuring better communication with the outside world (Carli & al., 2013). Thus, performance measurement and monitoring are essential to enable cities to clarify their mission and translate it into action (Carli & al., 2013).

Performance is a concept that is far more complex than just "smartness". In line with the definition in the introduction, **performance in Smart Cities implies measurement of the advances of a city towards its capacity to deliver a better quality of life to its citizens** (Merli & Bonollo, 2013). In this regard, a successful Smart City possesses an adequate performance measurement system that collects all the information required to develop effective participation from its stakeholders (e.g. associations, citizens, organisations, voluntary associations, universities, schools, cultural institutions, local facilities, public security forces). Performance measurement systems for Smart Cities must not solely consist in gathering data. They must be characterised by analyses that express the diversity and complexity of what is being measured while, at the same time, remaining easy to understand and satisfying the information needed by stakeholders (Lazaroiu & Roscia, 2012).

Before moving on to the next section, two further terms used in this report require clarification: monitoring and evaluation. Monitoring is the process of "*systematically collecting data on specified indicators to provide management (...) with indications of the extent of progress and achievement of objectives and progress*" (OECD 2002, p. 27). To link to the other terms previously used, monitoring is a part of the performance measurement process alongside other elements such as indicators and targets. Evaluation can be defined as "*the systematic and objective assessment of an ongoing or completed project, programme or policy, including its design, implementation and results*". (OECD, 2002, p. 21). Evaluation is a point in time that lies between performance measurement and performance management. On the basis of what has been found in the performance measurement process, an evaluation is made to decide what actions are taken in terms of performance management.

02

METHODOLOGY

To ensure the quality of this report, its scope must be reduced. To that end, it is imperative to understand what type of performance measurement approach we want to focus on. The performance management literature – from which performance measurement derives – distinguishes two main approaches: the outside-in and the inside-out approach (Kaas & al., 2006; Malmi & Brown, 2008, Dameri, 2017b).

On the one hand, the 'outside-in(ward)' approach, also called the output-input approach, consists in defining measurement and management activities based on issues and topics present in the public debate. In this case, one could claim that indicators become a policy instrument to exert peer pressure among cities to perform better (Maas & al., 2016). This is the approach for the measurement of Smart City performance put forward by several scholars such as Giffinger & al. (2007). However, Dameri (2017b) argues that this approach does not really focus on the need to understand or measure the value produced by Smart City strategies for citizens. As put by Bouckaert & Van Dooren (2009), benchmarking requires a high degree of comparability between the compared entities. Contrarily, cities often differ in many aspects (i.e., size, inhabitants, geographical specificities, etc.) (Kourtit & al., 2014). Calculations are made using measurements that are not always linked to the core components of a Smart City, but rather consider the sum of the urban equipment, from green areas to creative companies (ibid.). This produces a ranking of cities based on how well they implement urban administration, instead of the evaluation of Smart City strategies as a whole (ibid.).

On the other end of the spectrum, the inside-out perspective centres on performance improvement (Kaas & al., 2006), and is the focus of this report. This approach is based on the very core of a municipality's strategy and on the analysis of what issues are relevant for the effective implementation of this strategy. It also provides an overview of the aspirations of a city. This measurement is generally derived from a city's mission statement or general policy documents (Bouckaert & Van Dooren, 2009).

The data collection method of this report is based on a literature review previously undertaken by Van Bockhaven & Crutzen (2018). Their systematic literature review focuses on all publications that relate to performance management in Smart Cities. A more detailed explanation of the methodology is available in Appendix 2.

03

AN INTEGRATIVE METHOD FOR MEASURING SMART CITY PERFORMANCE

ESSENTIALS OF PERFORMANCE MEASUREMENT

As the inside-out perspective is based on strategy and the analysis of what issues are relevant, one needs to proceed meticulously in order to effectively understand what to measure and how to measure it. We briefly cover the main steps here. For more detail, readers are invited to refer to the Smart City Institute's Practical Guide on the Smart City (available in French and Dutch only)[2].

As a start, it is necessary for a municipality to understand its territorial, cultural, historical, structural and organisational specificities (Tahir & Darton, 2010). The main barrier to the development of Smart Cities is often political complexity: how cities are operated, financed regulated and planned (ibid.). Thus, before developing any strategy, one must conduct an in-depth review to understand where the municipality stands. This includes a summary of major processes and stakeholder interests or concerns (ibid.).

Once the municipality understands the general context and structure it is working with, it must understand what Smart City means to them and what the added value of the Smart City is in the long-term. This is very important as, depending on the significance and sense given to the concept of Smart City, different measures of performance will be implemented (Albino & al., 2012). **Municipalities must ask themselves how technology can be helpful in their sustainable transition process.**

After the municipality has defined what its Smart City long-term vision is, this vision needs to be turned into more operational objectives (outcomes). Outcomes are objectives that focus on an intermediate timeframe (5 to 10 years). They are – to a certain extent – the first strategic priorities for reaching global objectives. The indicators and targets will be derived these expected outcomes. As mentioned by Kusek & Rist (2004), the outcome will illustrate what success looks like (p. 57).

EXAMPLE

A municipality decides that they would like to develop local food production (objective/goal). They invest money to develop an online platform to support local farmers and hire someone to manage it (input). This platform will be developed by an external company (activity) and, when ready, citizens will visit this platform (activity). Consequently, the number of clients that decide to consume locally produced food may rise rapidly (output). In turn, as citizens develop ties with local food producers, they may change their behaviour in the medium-term and choose to shop locally instead of driving to supermarkets in the next village (outcome).

When outcomes are defined, the municipalities must develop a plan to outline how they will achieve those outcomes. In short, they must choose which inputs go into the organisation, the activities or processes for which the inputs will be used and the outputs that will result from these activities/processes (Bouckaert & Van Dooren, 2009, pp. 153-54). Inputs are "what you put into the process" such as money, human resources, infrastructure. With these inputs, activities

[2] Nguyen, C. T.-L., Bleus, H., Van Bockhaven, J., & Crutzen, N. (2017). Smart City: Le Guide Pratique. Liege, Belgium: Smart City Institute.

are undertaken (e.g. construction, online platforms, events). From these activities outputs result that in turn will lead to outcomes. Zairi (1997) defines a process as an approach for converting inputs into outputs. This is the way in which all the resources of an organisation are used in a reliable, repeatable and consistent way to achieve its goals (in Glavan, 2011). Figure 1 summarises this reflection.

When defining the long term-vision, the desired outcomes and the consequent plans to reach them, it is also **crucial that municipalities work as much as possible with stakeholder groups.** In business as in politics, setting goals must be done in conjunction with the main internal and external stakeholders and citizens to build consensus, gain a commitment and ensure ownership. If the community is not involved, smart innovation remains the dominion of the few and risks being perceived as elitist (Schaltegger & Wagener, 2006; Bouckaert & Van Dooren, 2009; Merli, 2014).

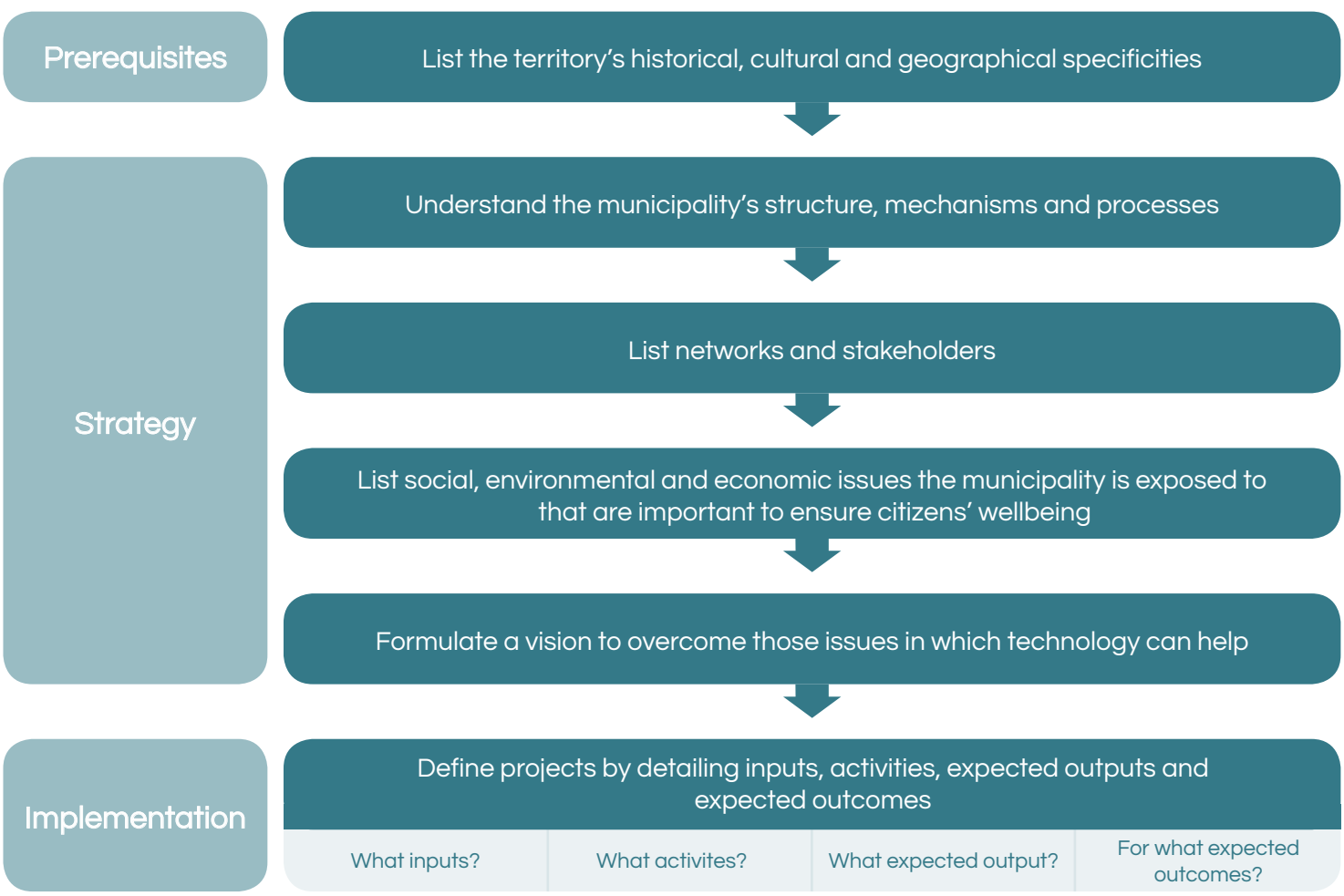

Fig. 1. Essentials of performance measurement

PERFORMANCE MEASUREMENT

Once the objectives and practicalities of the Smart City strategy are clear, we move to the core of this report: performance measurement. In this section, we describe the process to define indicators, targets, data collection methods and data valorisation.

INDICATOR DEFINITIONS AND TARGETS

Performance indicators are variables that tell us how far we have come toward reaching the objectives of our strategies and plans (Bouckaert & Van Dooren, 2009; Ferreira & Otley, 2009). **Developing performance indicators in public administrations encompasses numerous, intangible and conflicting goals with a rigid hierarchical structure, and sometimes involves a low operating efficiency** (Lundberg & al., 2009). Merli (2014) explains that, for Smart Cities, the "what" to measure refers to the performance of local government, which is quite a complex concept because of the variety of activities performed. Local governments usually play both the lead role and act as the director of the Smart City (ibid.). Each city chooses which indicators are used for systematic monitoring. Hence, it is important to go beyond performance and look at the whole strategy process (ibid.).

Based on a combination of what is proposed by Merli (2014) and Huovila & al. (2019), we hereby propose 4 types of indicators: input indicators, process/activity indicators, outcome indicators and output indicators. These can be qualitiative or quantitative. More information is available in figure 2.

In approaching the concrete selection of specific indicators for each category, there are several possibilities. For one option, municipalities can choose to develop their own set of indicators. The development of specific indicators falling within those categories is challenging as they need to satisfy the so-called **SMART (specific, measurable, achievable, relevant and time-bound)** principles, while at same time serving several purposes and audiences (Carli & al., 2014). Indicators are often selected either on the basis of historical practices and regulations or expert knowledge and the degree to which, individually, they meet a number of criteria (Niemeijer & Groot, 2008).

An effective Smart City indicator system should :

- address strategic, political and operational levels ;
- establish measurement over time based mainly on real-time data ;
- be evidenced against baseline measures and strategic targets with consistent and comparable (urban) data (Caird, 2017).

Quantitative indicators should be reported in terms of a specific number or percentage. Qualitative indicators provide insight into changes in institutional processes, attitudes, beliefs, motives and behaviours of individuals. However, this qualitative information is time consuming to collect and measure and should be used with caution (Kusek & Rist, 2004).

Before opting for the definition of their own set of indicators, municipalities should be aware that this process takes time as the indicators must be defined and validated. This requires the inclusion of contributions from technical and policy experts (Kusek & Rist, 2004). Cities in the UK such as Bristol, Birmingham and Manchester report on hundreds of performance indicators as part of their city performance reporting, and many of the indicators reported have links to their Smart City work i.e., energy, climate change, transport, waste and the liveability of the city (Caird, 2017).

As defining their own set of indicators in an efficient manner can be time consuming, authorities can be inspired by existing indicators. While the aim of this report is not to encourage municipalities to use ready-to-use frameworks (for the reasons mentioned above), the list of indicators within existing frameworks can be used for inspiration. Indicators from CityKeys are available online at http://nws.eurocities.eu/MediaShell/media/CITYkeystheindicators.pdf.

To be effective, **indicators must be completed with targets.** Targets are specified objectives that indicate the number, timing and location of that which is to be achieved (Ferreira & Otley, 2009). To define reachable targets, municipalities must ask themselves what level of performance they need to achieve for each indicator, how they go about setting appropriate performance targets for these indicators, and how challenging those performance targets are (ibid.). To set realistic targets, municipalities must have a baseline scenario to compare their performance to.

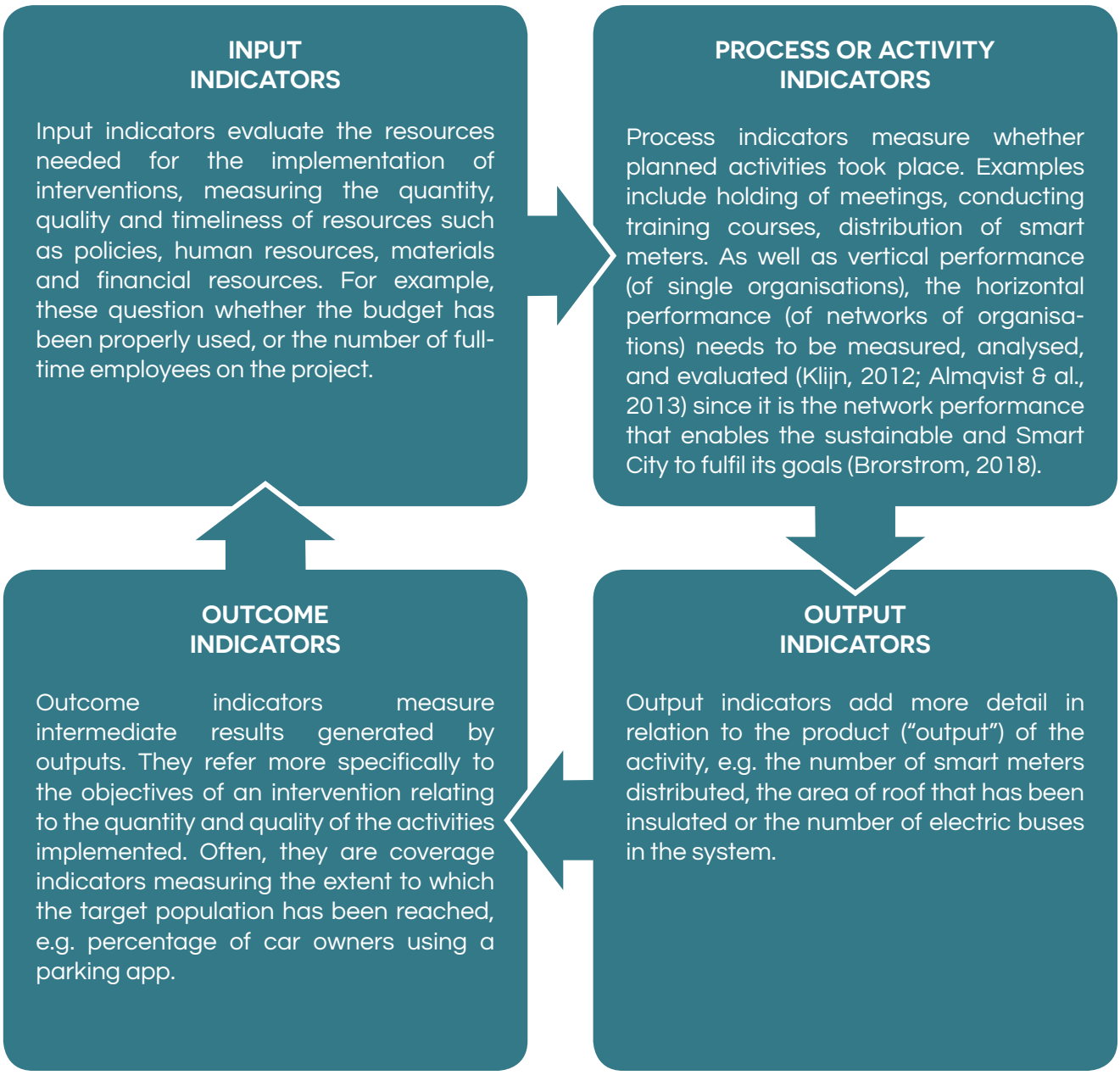

Fig. 2. Types of indicators

DATA COLLECTION METHOD

To understand where the municipality stands now and where they want to go, they must set a **data collection method that clarifies what type of data (e.g. public opinion, statistics, data from sensors) they aim to collect and how they collect it** (Kusek & Rist, 2004). A wide range of data collection methods exist. Data can be gathered through interviews, from informal and less structured (e.g. conversations with concerned individuals, field visits) to very formal and structured interviews (e.g. panel survey, field experiments) (ibid.). Data can also be gathered thanks to the technologies put in place on the smart territory such as sensors, cameras, apps, geolocalisation and social media (Ferrara, 2019). Data can also be obtained from third parties and private entities. Means must be chosen in relation to the audience to be reached, the accessibility of information, the attractiveness and the message (Merli, 2014). When choosing a method, one must keep in mind that every measurement activity incurs costs to implement and maintain (Glavan, 2011). Hence, **it is important to truly understand who will collect the data, how often it will be collected, what is the cost and difficulty of collection, who will analyse the data and who will report it** (Kusek & Rist, 2004; Ferreira & Otley, 2009). One must be aware that the data management cycle is not an easy process. The data needs to be collected, treated and stored (Ferrara, 2019).

Here are a few aspects that must be considered when dealing with data collection:

- Capacity to collect the data (i.e., human and financial resources) ;
- Data security (i.e., privacy, intellectual property, cybersecurity and risks of hacking) ;
- Legislation (e.g. GDPR in the European Union) ;
- Availability (i.e., can we get access to the data?) ;
- Integrity (i.e., quality, trustworthiness, pertinence) ;
- Compatibility and interoperability (i.e., ensuring that the gathered data can be read and exploited on different computer systems) (Ferrara, 2019).

This last point is particularly problematic. Many current Internet of Things (IoT) systems, for example for air quality monitoring or for the smart home, are either incomplete systems with restricted functionalities (i.e., in terms of sensing, storage, analytics), or are closed, proprietary systems dedicated to a specific function (Ahlgren & al., 2016). Fältström (2016) also argues that market forces work against open interoperability, especially in the IoT domain where, for example, a smart lighting system from one producer only works with light bulbs from the same producer. Hence, it is also complicated to extract, use and compare data from such restricted exploitation systems. Consequently, this brings us back to the very start of the Smart City strategy. When feasible, projects should embrace open standards. The IoT infrastructure, connectivity, platforms, devices and services should be constructed on open and largely implemented norms that can be used and exploited in an efficient way (Ferrara, 2019).


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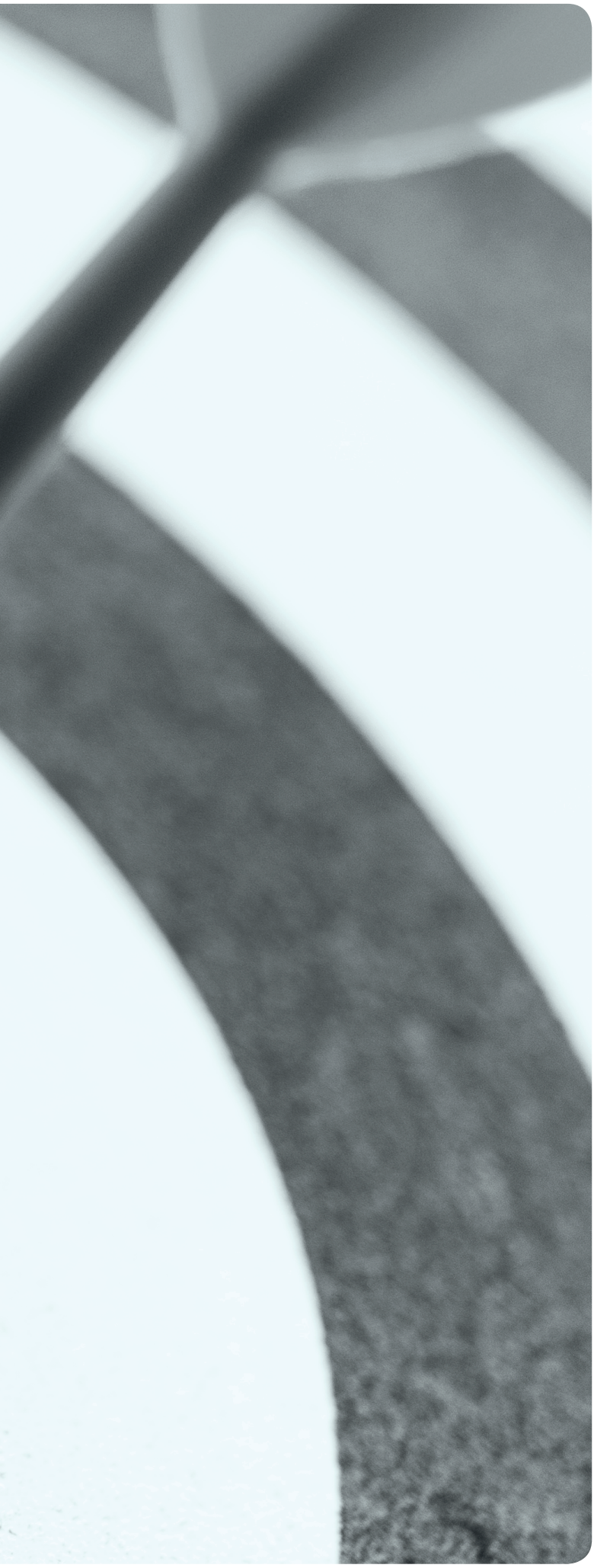


TARGETS

When the collection method is defined, municipalities can set realistic targets. **The value given to those targets can be considered as the addition of the "baseline indicator level" (measurement of today) and the desired level of improvement** (Kusek & Rist, 2004). For example, if authorities have identified that the air is highly polluted, reaching a concentration of fine particles of 50 mg/m3 on peak days, the target may be to reach a maximum of 25 µg/m3 (WHO limit) by the end of 2020. Municipalities also have to acknowledge that the most desirable outcomes are longer term, complex and not quickly achievable (Kusek & Rist, 2004). Most governments cannot reliably predict what their resources and inputs will be in 10 years. Hence it is important to set interim targets over shorter periods of time (ibid.).

DATA VALORISATION

At a later stage, throughout the monitoring process, gathered information must be valorised. Remember, **findings can be used to demonstrate accountability, convince, educate, explore and investigate as well as document, involve and promote understanding** (Kusek & Rist, 2004). **Data can be used and valorised through dashboards, decision tools, written summaries, executive summaries or visual presentations** (Ferrara, 2019).

To make a link with the previous section, municipalities can choose to valorise their data by sharing them as open data. Open data is data that can be freely used, re-used and redistributed by anyone – subject only, at most, to the requirement to attribute and share alike (Open Definition, n.d.). Data can be shared on websites, portals or specific application programming interfaces (API) (Ferrara, 2019). Open data can be used to:

- Allow a better understanding of the territory ;
- Reinforce policy making transparency ;
- Develop services, support the local economy and favour innovation ;
- Modernise policy making ;
- Develop citizen participation (ibid.).

Developing an open data policy requires a lot of preparation and planning. It requires its own strategy and must conceal the points of view of all involved stakeholders (i.e., management, communication, IT, operators) (ibid.)[3]. Not all municipalities are ready, capable and/or willing to open their data.

In the literature, a very commonly cited valorisation method is reporting (e.g. Hezri & Dovers, 2006; Yongvanich & Guthrie, 2006; Huovila & al., 2019). Reporting is an opportunity to develop feedback loops that link the performance improvement perspective with the transparency perspective (Maas & al., 2016). Reporting can be done through formal and informal channels. It can take the form of an annual report for city stakeholders and politicians. As an example, cities such as Birmingham and Manchester publish Annual State of the City Reports (Caird, 2017). One can also bring stakeholders and evaluators together to discuss findings, insights, alternative actions and next steps (Kusek & Rist, 2004). The cities of Peterborough and Bristol report on their Smart City work, respectively, through public forums or open stakeholders' meetings (Caird, 2017).

It is crucial to remember that **a good performance measurement system is primarily intended to reveal problems, not just to publicise good news and applaud administrations.** Consequently, the performance reports should explain – when possible – the reasons for poor outcomes and identify steps taken or planned to correct problems (Kusek & Rist, 2004). Moreover, simply recommending that certain actions be taken is rarely sufficient (Wholey & al., 1994, in Kusek & Rist, 2004). As claimed by Bouckaert & Van Dooren (2009) "performance measurement only becomes valuable when it is followed by management action and is only useful if it improves policy" (p. 156). Reporting can help to improve performance if managers and officials are willing to use their performance data for internal improvement (Maas & al., 2016). Consequently, the gathered performance data must be used to improve and adjust the Smart City strategy and objectives.

[3] For more information, see Ferrara, C. (2019). *Nos territoires face aux données et à leur gouvernance*. Smart City Institute (in French only)

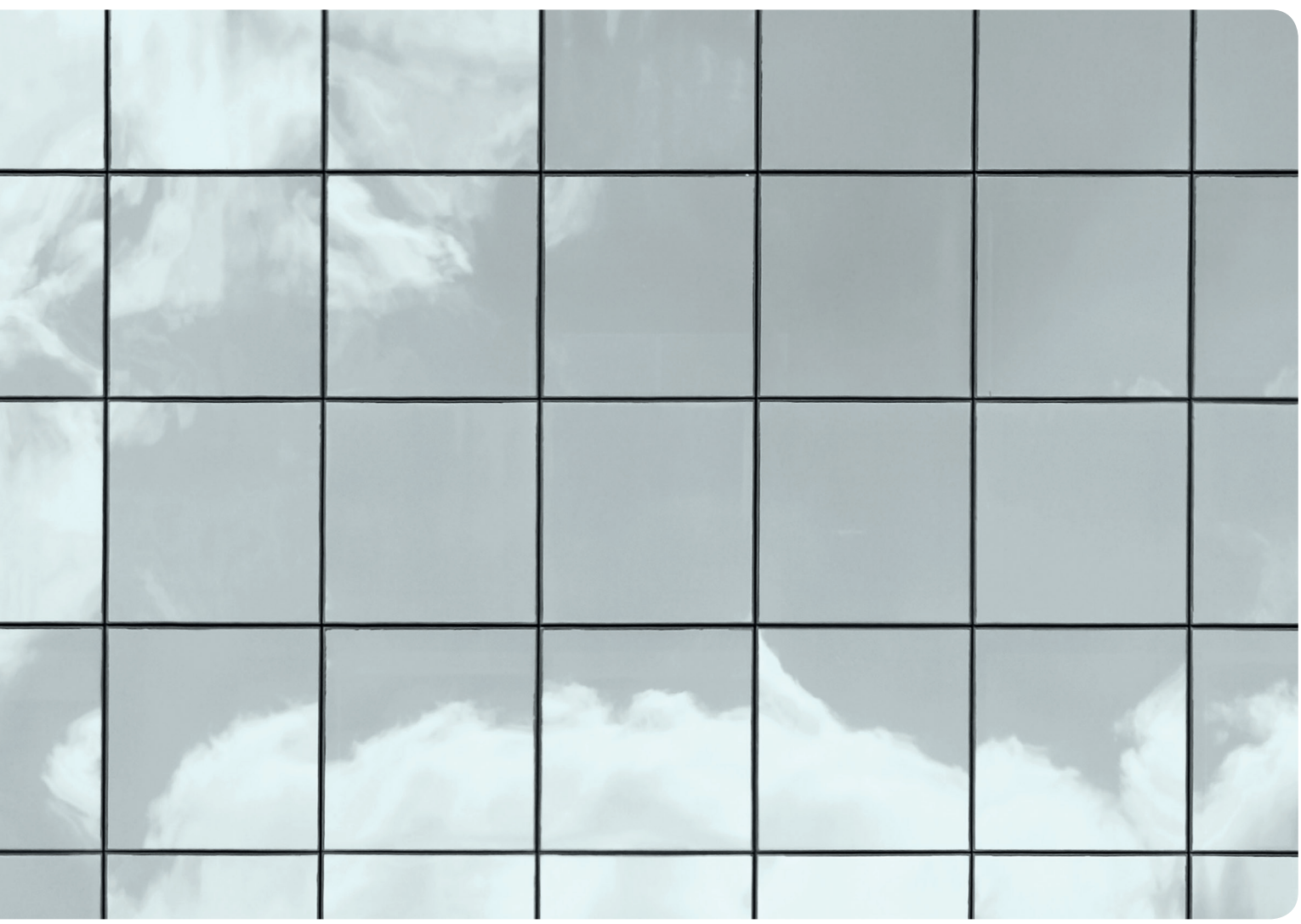
04

CONCLUSION

This report is intended to introduce municipalities to the concept of performance measurement in the context of Smart Cities and to provide them with a method that allows them to construct their own Smart City performance measurement system.

In this respect, we started the document by analysing how performance measurement evolved from being a purely business concept to becoming an integral part of any policy making process. We also described why it matters in the Smart City context: mainly for the rationalisation of resources, the prioritisation of actions and the reinforcement of communication and transparency. As a next step, we clarified our angle of approach and highlighted that the inside-out management approach is the most suitable to build a monitoring methodology that truly takes municipalities' specificities and objectives into account. Later, in the core of this report, we built a step by step method based on the existing literature. We briefly returned to the need for municipalities to know their territorial specificities and processes; the importance of defining what they mean by "Smart City", their long-term objectives and strategy. We then moved to the core of the report by explaining how to measure performance. First, we described the different types of indicators necessary to effectively measure the advances of Smart City strategies (i.e., input, process, output, outcome indicators) and proposed alternatives to define them (i.e., own definition method vs. inspiration from existing frameworks). Second, we explained the necessity to establish proper data collection methods to define baseline scenarios and mid-term targets. We put emphasis on key considerations such as the capacity to collect data, interoperability and privacy issues. Lastly, we suggested a couple of solutions to valorise collected data, namely open data and reporting.

Although we tried to produce a document that is as concise and objective as possible, there are a couple of limitations to mention. We have used a relatively academic tone that can make the information inaccessible to some policy makers. In addition, the report is only an introduction to Smart City performance measurement. This provides a quick glance through the whole process. What is needed in the future is a more practical handbook or tool for municipalities that goes deeper into each aspect of performance measurement and even extends the explanation to performance management.



APPENDICES

RECAP CHECKLIST

APPENDIX 1

0. PREREQUISITES

- ☐ List the territory's historical, cultural and geographical specificities.

1. STRATEGY

- ☐ Understand the municipality's structure, mechanisms and processes used.
- ☐ List networks and stakeholders.
- ☐ List social, environmental and economic issues the municipality is exposed to that are important to ensure citizens' well-being.
- ☐ List the territory's historical, cultural and geographical specificities.

2. IMPLEMENTATION

- ☐ Define projects by detailing input, activities, expected outputs and expected outcomes.

3. PERFORMANCE MEASUREMENT

- ☐ Define input, process, output and outcome indicators.
- ☐ Define a data collection method.
- ☐ Calculate where you stand now.
- ☐ Define targets.
- ☐ Implement.
- ☐ Valorise information & adapt strategy.

DATA COLLECTION METHOD

APPENDIX 2

The model proposed in this report is based on a data collection method adapted from a literature review previously undertaken by Van Bockhaven & Crutzen (2018). Their systematic literature review focuses on all publications that relate to performance management in Smart Cities. Since there is a lack of common definition of the performance management terminology (Alach, 2017; Maas, Schaltegger & Crutzen, 2016), the appearance of common terms that are associated with performance management in the title and abstract was used to find relevant articles, books and book sections. The searched keywords include "smart cit*" AND (control OR monitoring OR evaluation OR accounting OR "impact assessment" OR reporting OR "performance measurement" OR "performance management" OR benchmarking OR strateg* OR objective OR indicator). Three different databases (Scopus, EBSCO and Science Direct) were consulted and the combined results form the basis of the literature search, providing 789 unique hits consisting of articles and book sections.

The database search returned a great number of articles that are very diverse in scope and topic and only a minority of the articles appeared relevant to this research question. To select a subset of articles that relate to the topic of Smart Cities and performance management, three different classification systems were used: the level of analysis, domain and discipline (Giffinger & al., 2007; Letaifa, 2015; Ricciardi & Za, 2015). Letaifa (2015) describes 3 different dimensions for strategising Smart Cities: "The macro level comprises the strategy design and mobilisation of multidisciplinary resources. The mezzo level refers to actors' appropriation of the project and the implementation of a clear roadmap. Finally, the micro level tackles the technological transformation necessary for the implementation of new high-value-added services for residents". Giffinger, (2007) defined 6 dimensions of the Smart City: smart economy, smart people, smart governance, smart mobility, smart environment and smart living, each with their own specificities. Ricciardi & Za (2015) developed a framework to categorise Smart City research, comprising 7 different disciplines including management and organisation studies. For this literature review, articles discussing the macro analytical level, all smart domains and management and organisation studies were selected from the database search. Two researchers independently screened all the 789 database hits and only the publications that were selected unanimously served as the base of this literature review, resulting in a total of 89 publications.

SMART CITY INSTITUTE

APPENDIX 3

The Smart City Institute is an academic institute dedicated to the thematic of Smart Cities. It is based on an original partnership between private companies (Proximus, Schréder, Strategy&, Total and Vinci Energies), a University (ULiège) and its Management School (HEC Liège) and Wallonia.

THE MISSION OF THE SMART CITY INSTITUTE

> *"to contribute to the general development of Smart Cities by training future managers, developing research, entrepreneurship and innovation as well as facilitating sustainable value creation between actors of smart ecosystems thanks to networking and thanks to an access to multidisciplinary skills and to the most innovative technologies"*

This academic institute consists of :

- Professors, scientific researchers and projects managers ;
- Public and private partners:
  - As a digital partner, thanks to the solutions that the company develops and offers, **Proximus** particularly supports innovation and entrepreneurship;
  - **Schréder** is fully committed to developing innovative technologies that help cities to meet the challenges of tomorrow. Therefore, it works alongside cities, research centers and technology start-ups to develop solutions which meet the needs of future generations;
  - **Strategy&** (part of PwC) provides expertise in strategic consulting and Smart Cities;
  - As part of its "Committed to Better Energy" ambition and as a major player in the electricity, gas and fuel cards markets, **TOTAL** joins the Smart City Institute to jointly seek solutions related to the challenges of intelligent management of energy, but also of mobility.
  - **Vinci Energies** contributes to the development of the institute by sharing its expertise in numerous areas for Smart Cities (transport, energy and communication networks, Smart Grids, etc.)
  - **Wallonia** supports the institute and more specifically the plan Digital Wallonia.
  - The Institute is also one of the stakeholders in the **Wal-e-Cities** project (European funding FEDER) to support the development of Smart Cities initiatives throughout the country.
  - The Institute is also working on the "**GROOF**" project (European INTERREG-NWE funding), an innovative project aimed at reducing CO^2 emissions through the installation of a roof greenhouse system.
- Experts in the development of the "Smart Cities" (experts in technology, real estate, infrastructures, financial services, energy, project management).

To tackle its mission, the Smart City Institute is developing three complementary activities (three pillars of the SCI): research, teaching and supporting entrepreneurship. These activities are supported by transversal activities of awareness.

From its beginning, a real national and international perspective will be given to the activities led by the Smart City Institute. Finally, even if it is true that the issues and challenges of Smart Cities need to be analysed under the angle of various disciplines, management is clearly a crucial axis which has been little investigated, as proposed by Smart City Institute.

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